



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

Nuclear Explosives Code Development Conference Unclassified Proceedings (NECDC 2004)

R. J. Procassini, B. K. Wallin

February 13, 2007

Nuclear Explosives Code Development Conference 2004
(NECDC 2004)
Livermore, CA, United States
October 4, 2004 through October 7, 2004

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

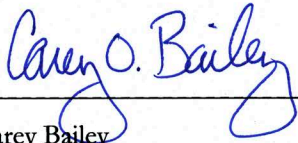


September 30, 2012

2012 LLNL Multi-Year Site Sustainability Investment Proposal

2012 Multi-Year Site Sustainability Investment Proposal

Submitted by:



Carey Bailey

LLNL Operations Lead for Site Sustainability, Institutional Facilities Manager (Acting),
and Project Management, Engineering, and Construction Department Head

Contributing Authors

Janet Adams
Anna Maria Bailey
Paul Chu
Jennifer Doman
Noah Goldstein

Bill Howing
Susi Jackson
Mike Payne
Jose Pineda
Barbara Pulliam

Sal Ruiz
Mark Sampson
Marriann Silveira
Greg Stremel
Alison Terrill

Clint Worland
Jesse Yow

About the Cover

The images on the cover represent a few of the many facility and infrastructure projects that support LLNL's sustainability effort.

Left: Replacing approximately 200 street and pathway light fixtures with LEDs.

Center: Installing and replacing meters to track energy usage.

Right: Installing new programmable thermostats to reduce electricity consumption.

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

IFM-12-0065_RevA

LLNL-AR-580452

Table of Contents

List of Figures	iii
List of Acronyms	iv
Executive Summary.....	1-1
Supporting the LLNL Sustainability and Mission Goals	1-1
Project Portfolio Overview	1-2
Major Planning Assumptions and Issues	1-3
Successes and Challenges in Sustainability	2-1
Successes	2-1
Challenges.....	2-2
Sustainability Goals	3-1
Goal 1.1: 28% Scope 1 & 2 GHG reduction by FY20 from a FY08 baseline	3-1
Goal 1.2: 30% energy intensity reduction by FY15 from a FY03 baseline.....	3-4
Goal 1.3: Individual buildings or processes metering for electricity, steam, natural gas, and chilled water	3-7
Goal 1.4: Cool roofs, unless uneconomical, for roof replacements unless project already has CD-2 approval	3-8
Goal 1.5: 7.5% of annual electricity consumption from renewable sources by FY13 and thereafter.....	3-9
Goal 1.6: 10% annual increase in fleet alternative fuel consumption by FY15 relative to a FY05 baseline	3-11
Goal 1.7: 2% annual reduction in fleet petroleum consumption by FY20 relative to a FY05 baseline.....	3-12
Goal 1.8: 75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) starting in FY00 and thereafter	3-13
Goal 1.9: Reduce fleet inventory by 35% within the next 3 years relative to a FY05 baseline.....	3-14
Goal 2.1: 13% Scope 3 GHG reduction by FY20 from a FY08 baseline	3-14

Goal 3.1: 15% of the number of existing buildings greater than 5,000 gsf to be compliant with the five guiding principles of HPSB by FY15.....	3-16
Goal 3.2: All new construction, major renovations, and alterations of buildings greater than 5,000 gsf must comply with the GPs and where the work exceeds \$5 million, each are LEED-NC Gold certification or equivalent.....	3-17
Goal 3.3: Regional and local planning.....	3-17
Goal 4.1: 26% water intensity reduction by FY20 from a FY07 baseline.....	3-19
Goal 4.2: 20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY20 from a FY10 baseline.....	3-21
Goals 5.1 and 5.2: Recycling and waste diversion	3-22
Goal 6.1: Procurements meet sustainability requirements by including necessary provisions and clauses	3-24
Goal 7.1: All data centers are metered to measure a monthly PUE.....	3-25
Goal 7.2: Maximum annual weighted average PUE of 1.4 by FY15	3-26
Goal 7.3: Electronic stewardship—100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY12.....	3-27
Goal 8: Site innovation and government-wide support	3-28

List of Figures

Section 3

Figure 1-1	DOE sustainability goals, project costs, annual savings, and simple payback	1-2
Figure 1-2	Funding required to achieve sustainability goals	1-3
Figure 3-1	The three major scopes of GHG emissions.....	3-1
Figure 3-2	Estimated LLNL GHG emissions	3-3
Figure 3-3	Energy use intensity savings through end of FY12.....	3-4
Figure 3-4	LLNL typical energy use breakdown	3-5
Figure 3-5	Lab-wide energy savings projects in progress	3-6
Figure 3-6	Proposed projects in support of SSPP Goal 1.2	3-7
Figure 3-7	Proposed projects in support of SSPP Goal 1.3	3-8
Figure 3-8	LLNL roof expected life cycle.....	3-8
Figure 3-9	Proposed projects in support of SSPP Goal 1.4	3-9
Figure 3-10	Cool roof electricity savings	3-10
Figure 3-11	Proposed projects in support of SSPP Goal 1.5	3-11
Figure 3-12	Proposed projects in support of SSPP Goal 1.7	3-13
Figure 3-13	Proposed projects in support of SSPP Goal 1.8	3-13
Figure 3-14	Proposed projects in support of SSPP Goal 1.9	3-14
Figure 3-15	Proposed projects in support of SSPP Goal 2.1	3-16
Figure 3-16	Proposed projects in support of SSPP Goal 3.1	3-16
Figure 3-17	Typical breakdown of LLNL potable water use	3-19
Figure 3-18	Potential approaches to future potable water savings	3-20
Figure 3-19	Proposed projects in support of SSPP Goal 4.1	3-21
Figure 3-20	Priority chemical purchases	3-22
Figure 3-21	Proposed projects in support of SSPP Goals 5.1 and 5.2	3-23
Figure 3-22	Proposed projects in support of SSPP Goal 7.1	3-25

Figure 3-23	Free cooling concept at the TSF.....	3-26
Figure 3-24	Proposed projects in support of SSPP Goal 7.2	3-27
Figure 3-25	Annual savings estimate to be achieved from power management...	3-27
Figure 3-26	Proposed projects in support of SSPP Goal 7.3	3-28
Figure 3-27	Communicating the “sustainability message” through posters.....	3-30

List of Acronyms

ATI	Award Term Incentive
BTU	British thermal unit
CBFI	Capability Based Facilities and Infrastructure
CEDR	Consolidated Energy Data Report
CVP	Central Valley Project
DDC	direct digital control
DOE	U.S. Department of Energy
ECM	Energy Conservation Measure
EISA	Energy Independence and Security Act
EMCS	energy management control systems
EPACT	Energy Policy Act
ESPC	Energy Savings Performance Contract
FM	facility manager
GHG	greenhouse gas
GSA	General Services Administration
HFC	hydrofluorocarbon
HPC	high performance computing
HPCIC	High Performance Computing Innovation Center
HPSB	high performance sustainable building
HVAC	heating, ventilating, and air conditioning
kgals	one thousand gallons
kWh	kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design
LLNL	Lawrence Livermore National Laboratory
LLNS	Lawrence Livermore National Security, LLC
LSO	Livermore Site Office
MW	megawatts
MWh	megawatt hours
NIF	National Ignition Facility
NNSA	National Nuclear Security Administration

PFC	perfluorocompounds
PG&E	Pacific Gas & Electric
PPA	Power Purchase Agreement
REC	renewable energy credit
RIDGE	Renewables Innovation and Development for Generation of Electricity
ROI	return on investment
SF	square foot/feet
SF ₆	sulfur hexafluoride
Site 200	LLNL Main Livermore Site
Site 300	LLNL High-Explosives Experimental Test Site
SLAC	Stanford Linear Accelerator Center
SSP	Site Sustainability Plan (LLNL)
SSPP	Site Sustainability Performance Plan (DOE)
TSF	Terascale Simulation Facility
TYSP	Twenty-Five Year Site Plan
VFD	variable frequency drive
WAPA	Western Area Power Administration

Executive Summary

The Operations & Business Principal Directorate believes the proposed projects presented in this document will successfully reduce energy consumption and the generation of greenhouse gases (GHG) while significantly improving the quality of its facilities. Additionally, implementation of these projects will not only reduce energy use, but will allow the Laboratory to comply with federal and Department of Energy (DOE) conservation goals.

The solutions presented here are consistent with the guidance provided by DOE as a deliverable for the DOE Order 436.1 Departmental Sustainability requirement, and the LLNL FY12 Site Sustainability Plan (SSP). The goal numbers referenced in this document are those referenced in the DOE Site Sustainability Performance Plan (SSPP).

Supporting LLNL Sustainability and Mission Goals

LLNL's vision for site sustainability is to supply its programs with optimal conditions for success while undergoing continual improvement to existing energy infrastructure; to collaborate with growing mission areas to identify ways to innovate towards more energy efficient solutions for energy-intensive facilities; to pursue innovative renewable energy generation, both for on-site use and as an ongoing research area; and to incorporate energy efficiency improvements into the ongoing energy management and facility operations of LLNL.

Understanding the Laboratory's sustainability goals and challenges is paramount to delivering solutions and benefits that will have the lasting and valued impact desired. The efforts of this document are intended to directly support meeting the Laboratory's goals while improving the quality, efficiency, and reliability of its facilities and infrastructure.

LLNL stated project goals include:

- Exhibiting leadership in sustainability within the NNSA and DOE Complex
- Leveraging the expertise in relevant science and technology domains to improve site performance
- Creating a dynamic campus to maximize employee satisfaction and attract new recruits
- Reducing deferred maintenance
- Addressing technology obsolescence
- Complying with the goals of the Energy Policy Act of 2005 (EPA 2005) and DOE Order 436.1 *Departmental Sustainability*

Supporting sustainability

To support the federal government's sustainability effort, LLNL strives to reduce energy consumption, decrease fossil fuel use, adopt clean energy technologies, conserve water, cut greenhouse gas emissions and other pollutants, and recycle and reduce waste as we carry out our national security mission.

Project Portfolio Overview

A portfolio of projects has been developed based on the LLNL FY12 SSP and the LLNL FY13 Twenty-Five Year Site Plan (TYSP). The projects, if implemented, will help LLNL achieve all its sustainability goals. The projects presented result in a total investment of \$110M, and will achieve an estimated annual utility and operational savings of \$16M, for an aggregate simple payback of seven years. Not estimated is the improved quality of the facilities and their aesthetics.

The projected savings in this proposal were calculated from the LLNL FY12 Consolidated Energy Data Report (CEDR). The cost estimates were calculated from the FY13 LLNL TYSP. Figure 1-1 lists DOE Sustainability Goals and the cost required to meet those goals.

Goal #	Goal	Cost (\$M)	Annual Savings (\$M)	Simple Payback (Years)
1.1	28% Scope 1 & 2 GHG reduction by FY20 from a FY08 baseline	0	0	0
1.2	30% energy intensity reduction by FY15 from a FY03 baseline	32	7.3	4.3
1.3	Individual buildings or processes metering for 90% of electricity (by October 1, 2012); for 90% of steam, natural gas, and chilled water (by October 1, 2015)	0.5	0.09	55
1.4	Cool roofs, unless uneconomical, for roof replacements unless project already has CD-2 approval. New roofs must have thermal resistance of at least R-30.	6.3	0.5	42.5
1.5	7.5% of annual electricity consumption from renewable sources by FY13 and thereafter (5% FY10–12)	12.4	2.6	4.8
1.6	10% annual increase in fleet alternative fuel consumption by FY15 relative to a FY05 baseline	–	–	–
1.7	2% annual reduction in fleet petroleum consumption by FY20 relative to a FY05 baseline	2.5	–	–
1.8	75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) starting in FY00 and thereafter	–	–	–
1.9	Reduce fleet inventory by 35% within the next 3 years relative to a FY05 baseline	–	–	–
2.1	13% Scope 3 GHG reduction by FY20 from a FY08 baseline	1.2	0.6	2
3.1	15% of existing buildings greater than 5,000 gross square feet (GSF) are compliant with the Guiding Principles (GPs) of HPSB by FY15	0.5	0.06	7.7
3.2	All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the GPs and where the work exceeds \$5 million, each are LEED ® – NC Gold certification or equivalent	–	–	–
3.3	Regional and local planning	–	–	–
4.1	26% water intensity reduction by FY20 from a FY07 baseline	21.2	1.1	19.7
4.2	20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY20 from a FY10 baseline	–	–	–
5.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris, by FY15	2.5	0	–
5.2	Divert at least 50% of construction and demolition materials and debris by FY15	–	–	–
6.1	Procurements meet sustainability requirements and include sustainable acquisition clause (95% each year)	–	–	–
7.1	All data centers are metered to measure a monthly Power Utilization Effectiveness (PUE) (100% by FY15)	0.7	–	–
7.2	Maximum annual weighted average Power Utilization Effectiveness of 1.4 by FY15	25	3.3	7.6
7.3	Electronic Stewardship - 100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY12	0.15	0.013	12
8	Site innovation and government-wide support	–	–	–
	TOTALS	110	16	7

Figure 1-1. DOE sustainability goal titles, project costs, annual savings, and simple payback.

IFM-12-0040_RevA

Major Planning Assumptions and Issues

LLNL is planning for growth in mission-based facilities in the upcoming decade. The Laboratory's strategic goal is to lead the nation in stockpile science, innovation and sustainment, be the foremost national security laboratory, anticipating, innovating and delivering solutions for the nation's most challenging security problems, and be the premier destination for our nation's very best scientists and engineers.

These goals will likely require an increase in the LLNL workforce and infrastructure. Both employee commuting and wastewater emissions are directly related to the size of the LLNL workforce, which directly effects LLNL's GHG emissions. Impacts associated with the management of increased diversion of routine and non-routine wastes will have a positive effect on LLNL's GHG inventory.

Figure 1-2 details funding required, by fiscal year, in order to achieve sustainability goals as required by the various federal and DOE Orders. Projects detailed in this document assume that funding will be allocated by the beginning of the respective fiscal years. Work will be performed by purchase order subcontracts and managed by the Operations & Business Principal Directorate.

Sustainability Goal	Total (\$M)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)	FY17 (\$M)	FY18 (\$M)	FY19 (\$M)
1.1	–	–	–	–	–	–	–	–
1.2	31.9	13.0	9.9	9.0	0	0	0	0
1.3	5	1.7	1.7	1.7	0	0	0	0
1.4	6.25	1.1	2.3	2.9	0	0	0	0
1.5	12.4	0.2	6.1	6.1	0	0	0	0
1.6	–	–	–	–	–	–	–	–
1.7	2.5	0.8	0.8	0.8	0	0	0	0
1.8	–	–	–	–	–	–	–	–
1.9	–	–	–	–	–	–	–	–
2.1	1.2	0.4	0.4	0.4	0	0	0	0
3.1	0.45	0.15	0.15	0.15	0	0	0	0
3.2	–	–	–	–	–	–	–	–
3.3	–	–	–	–	–	–	–	–
4.1	21.2	0	0	1.0	5.3	6.8	3.8	4.4
4.2	–	–	–	–	–	–	–	–
5.1	2.5	0.63	0.63	0.63	0.63	–	–	–
5.2	–	–	–	–	–	–	–	–
6.1	–	–	–	–	–	–	–	–
7.1	0.7	0.2	0.2	0.2	0	0	0	0
7.2	25	1.5	16.8	6.8	0	0	0	0
7.3	0.15	0.15	0.15	0.15	–	–	–	–
8	–	–	–	–	–	–	–	–
TOTAL	110	20	39	30	6	7	4	4

IFM-12-0041_RevA

Figure 1-2. Funding required to achieve LLNL's sustainability goals.

Successes and Challenges in Sustainability

Successes

LLNL had a number of successes and challenges in the area of sustainability projects. The successes in site sustainability are manifold, and are outlined in this document. Major highlights include:

- Earning a DOE Secretary's Achievement Award for LLNL's "Contribution to the Fugitive Emission Working Group in reducing, complex-wide, SF₆ emissions by 50% (700,000 metric tons CO₂-e)."
- The development of the SF₆ Management Plan which will help LLNL further reduce its emissions.
- Earning an NNSA Best-In-Class award for the "LVOC High Performance Computing Innovation Center: LLNL Program and Facility Development with the Environment in Mind."
- Earning NNSA environmental stewardship awards for two joint LLNL-Sandia CA projects: "Fresh @ the Labs – an LLNL-SNL/CA Farmers Market Collaboration," and the "LLNL-Sandia/CA Hydrogen Shuttle Bus Collaborative Project."
- Earning an NNSA environmental stewardship award for "Innovative Green Cleaning."
- LLNL was among the first DOE sites to earn a DOE 2012 Green Buy Gold level award for "Sustainable Acquisition Practices."
- Deploying setback control thermostats in 95 of LLNL's facilities.
- Initiating a comingled recycling and composting pilot program in fifteen buildings, including all on-site cafeterias.
- Installing 826 low-flow domestic faucet aerators in rest rooms and kitchens site-wide.
- Running a one-year hydrogen bus taxi pilot program for DOE's Office of Energy Efficiency and Renewable Energy.
- Educating LLNL employees on sustainability at events and through the Sustainability Communications Plan.
- Spending approximately \$10M in support of the sustainability effort in FY12.
- Continuing to lead a robust scientific and research program that advances renewable energy research, building energy efficiency, climate change research, and GHG mitigation.

Making progress

LLNL is committed to meeting its mission responsibilities and conducting operations in a manner that is sensitive to its safety, security and environmental responsibilities. Over the past several years, progress has been made in many areas.

- Reducing greenhouse gas emissions by 13% (FY08 to FY12).
- Decreasing energy usage by 15% (compared to FY03 baseline).
- Surpassing its goal of 75% alternative fuel vehicles by FY15; all light-duty vehicles in the fleet run on either alternative fuel (primarily E85) or are hybrids.
- Saving 100 million gallons of water since the FY07 baseline.

LLNL was recognized by the DOE Livermore Site Office (LSO) in passing the FY11 Performance Evaluation Plan measure for sustainability as well as a FY11 Sustainable Management Award Term Incentive (ATI).

Challenges

LLNL is facing three ongoing challenges in the sustainability area. The first is that LLNL is poised to grow in mission areas that are particularly energy-intensive, such as high performance computing (HPC). Additionally, in support of the new mission growth, LLNL will need to increase its staffing levels in upcoming years. Both of these are indications of the success of the Lab's efforts in growing its programs. This projected growth will increase both LLNL's energy intensity and its associated greenhouse gas (GHG) emissions. This will be the case even as new computing centers and prospective new facilities are designed, built, and operated as efficiently as possible.

The second issue is that of aging facilities. Although LLNL has consistently replaced and upgraded equipment with the most efficient and cost-effective options, our older facilities continue to have a high energy intensity.

Lastly, it is very difficult to overcome LLNL's low cost of delivered electricity (~\$0.05 per kWh in FY12) to justify significant investments in energy conservation projects. A number of low-cost energy saving initiatives have been identified from the Energy Savings Performance Contract (ESPC) contractor and internally-funded facility audits, yet these will not make a significant impact in the Laboratory's overall energy consumption.

Institutional efforts = future reductions

Further decreases in energy consumption and greenhouse gas emissions will be particularly challenging as NIF ramps up to full operation, the Sequoia supercomputer is brought online, and staffing for growing programs increases.

Reducing electricity and fossil fuel usage will play a major role in reducing our greenhouse gas emissions. A major focus will be on sulfur hexafluoride (SF₆) emissions. At LLNL, SF₆ is used for its unique properties in diverse activities, including accelerator operations (at the Center for Accelerator Mass Spectrometry and elsewhere) and, to a lesser extent, in electrical power production and distribution equipment, flash x-ray units, transmission electron microscopes, and some etching technologies.

SF₆ emissions will be reduced by implementing modified operations, more efficient gas transfer and gas capture technologies, better leak detection, and increased preventative maintenance to preclude inadvertent releases.

Sustainability Goals

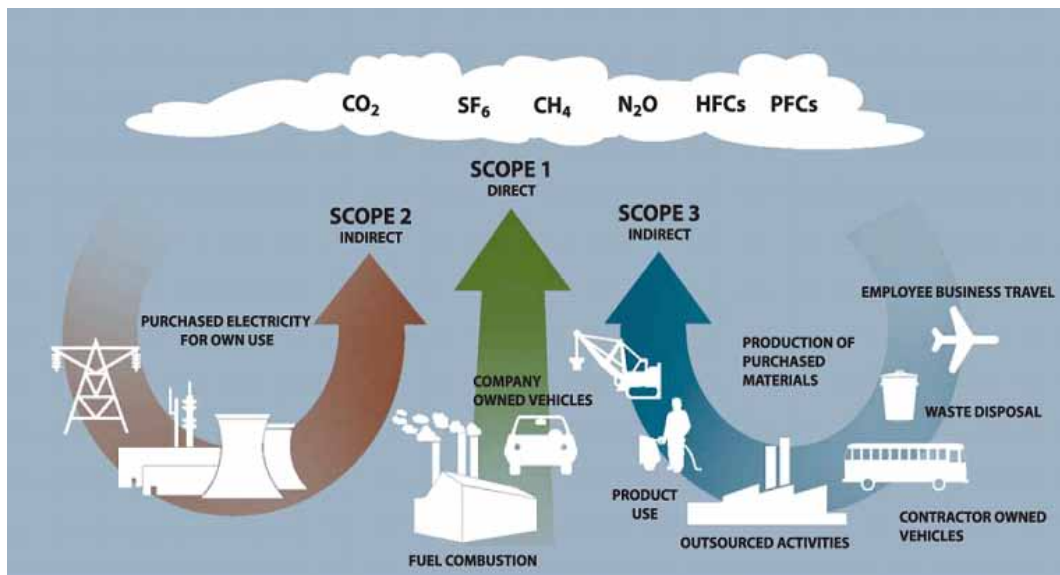
Goal 1.1

Goal: 28% Scope 1 & 2 GHG reduction by FY20 from a FY08 baseline

Performance Status

The boundaries that delineate the scope of LLNL's GHG inventory are defined by the three major scopes of GHG emissions (Figure 3-1). These scope boundaries also define the areas for GHG reductions and facilitate the quantification of various activities that can then be targeted. LLNL owns or controls sources from all three direct GHG emissions. LLNL's Scope 1 emissions result primarily from the following types of activities:

- Fuel combustion for the generation of electricity, heat, cooling, or steam (e.g., boilers, furnaces, and emergency generators)
- Mobile source agency controlled emissions that result from the combustion of fuels in mobile combustion sources including LLNL's General Services Administration (GSA)-leased vehicles, commercially leased, and agency-owned vehicles, and the emissions from biofuel combustion



Source: World Resources Institute (WRI)

IFM-10-0044_RevA

Figure 3-1. The three major scopes of GHG emissions.

- Fugitive emissions from intentional or unintentional releases of GHGs from within LLNL's organizational boundary
 - Equipment leaks from joints, seals, packing, and gaskets (SF₆)
 - Operation of the sewage lagoon at Site 300
 - Pure gases releases, such as carbon dioxide (CO₂) SF₆ and methane
 - Hydrofluorocarbon (HFC)/perfluorocompounds (PFC) emissions from the use of refrigeration and air conditioning equipment
 - Methane leaks from gas transport
 - SF₆ leaks from electrical and programmatic equipment

LLNL's Scope 2 emissions are a result of indirect emissions associated with consumption of purchased or acquired electricity. All other potential Scope 2 emissions are not applicable to LLNL.

Scope 1 and 2 successes are embedded in many of the activities and accomplishments discussed throughout this document, including:

- Energy intensity reduction
- Renewable energy consumption
- Reducing fleet petroleum use
- Metering
- Cool roofs
- SF₆ reduction and capture
- Computational efficiency

LLNL continues to stay on target to meet FY20 GHG reduction goals with reduced energy intensity and reductions in fugitive emissions.

In FY12, LLNL achieved a reduction of more than 13% in Scope 1 & 2 GHG emissions, relative to its FY08 baseline. The progress in Scope 1 & 2 GHG emissions reduction is due in large part to the increased management of SF₆ emissions. Other contributions include the installation of cool roofs, shutting down facilities, the thermostat setback initiative, improved fleet management, and a heightened awareness of electrical and natural gas usage site-wide. Figure 3-2 illustrates the source of LLNL's GHG emissions.

Planned Actions

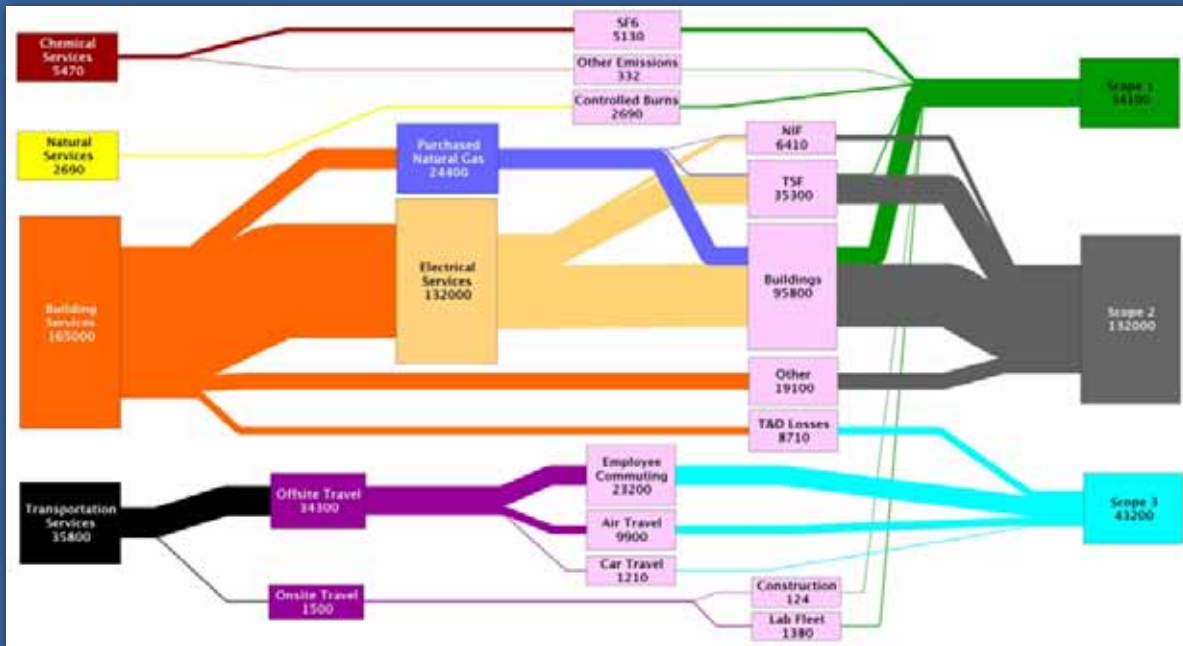
LLNL will aggressively continue to pursue GHG reduction efforts especially through continued management of fugitive emissions from equipment using SF₆, improving the measuring of SF₆ loss, and promoting alternatives to SF₆ where practical. Efforts will continue to manage gas and electric consumption through direct digital controls (DDC) and setback thermostat installations, and raising awareness of high energy consumption activities.

The measures described in this document all have the potential to assist in GHG emission reductions. Future growth of LLNL continues to be centered on energy-intensive facilities and research, including the National Ignition Facility (NIF), HPC, and other program-related areas, all of which will increase LLNL's GHG emissions. It should be noted that though LLNL may be successful with the reductions in energy intensity, this does not necessarily translate into overall GHG reductions. LLNL will continue to consider and look for additional opportunities to reduce the overall generation to emissions of GHGs.

Estimated LLNL GHG Emissions

The flowchart below illustrates the source, service, and classification of LLNL's GHG emissions.

The majority of LLNL's emissions are from building-related services. This is associated with electricity in all its forms (Scope 2). The TSF is a very large contributor, and emissions will continue to increase as the TSF and mission-related computing needs increase.



Source: LLNL 2011. Data is compiled from multiple sources, including individual building energy estimates, chemical estimates, and employee behavior. Chart units are in CO₂ equivalent Tonnes (tCO₂e).

Figure 3-2. Estimated LLNL GHG emissions.

It should also be noted that a fair degree of LLNL's Scope 2 emission are beyond its control. The GHGs associated with electricity generation originate at the energy provider. It is very likely that due to the drop in prices of natural gas and the renewable energy portfolio standards, the regional generation of electricity will shift its limited coal-based generation to less carbon-intensive sources. There is also the possibility that coal-based electricity can increase, making LLNL's GHG footprint even greater. LLNL is attempting to mitigate against this uncertainty by working with DOE on exploring renewable energy options for the site.

Funding Strategy

LLNL must reduce its GHG emissions by 39,000 metric tons to meet the established goals by 2020. The projects listed in subsequent sections all have the potential to assist in GHG emissions reductions. If the entire portfolio of projects is funded as proposed in this document, GHG emissions will be reduced by approximately 30,000 metric tons annually (based on FY12 carbon calculations). In order to meet the established goal, additional reductions of approximately 9,000 metric tons will need to be identified. In order to avoid confusion, the projects are listed only once in the Sustainability Goals section of this document.

Goal 1.2

Goal: 30% energy intensity reduction by FY15 from a FY03 baseline

Performance Status

For FY12, LLNL's energy intensity reduction savings is estimated to be 15%, relative to the FY03 baseline. This reduction is less than DOE's FY12 target of 21%, as stated in the LLNL SSP. However, if the space demolished since the baseline year is considered, LLNL would be at a -20.9% reduction, below the goal by more than 3%. This energy intensity reduction was achieved during a time of increased energy-intensive, mission-related research, and includes the shut down or demolition of 620K square feet of space. Figure 3-3 illustrates the savings.

Facility audit project recommendations performed under Energy Conservation Measure (ECM) 3.2 will result in an estimated savings of 26M BTU annually.

A number of approaches to conserving energy were evaluated and implemented in FY12. One approach has been to estimate the sources of energy by type. This estimate was updated with the latest FY11 data and was created by incorporating metered data, lighting estimates, and equipment inventory (Figure 3-4). HVAC systems (42%) and lighting (16%) continue to be the two largest users of energy at LLNL. The breakdown helps to indicate where specific energy conservation efforts should be directed.

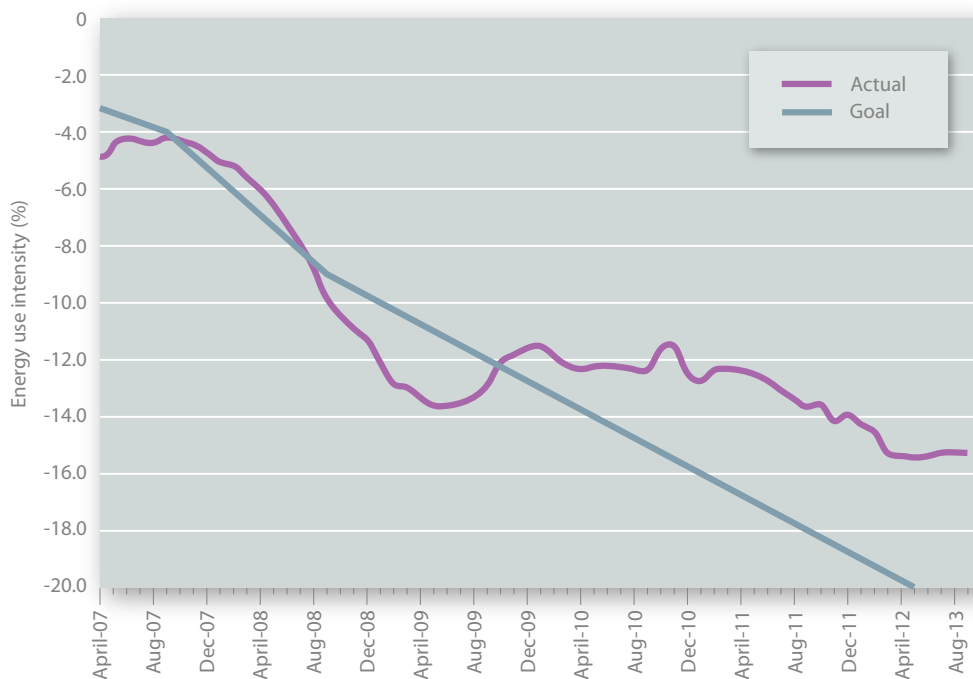


Figure 3-3. Energy use intensity savings through end of FY12 (running year energy intensity savings with REC purchases and FY10 exclusions).

Another approach used was to replace about approximately 200 street and pathway light fixtures with light-emitting diodes (LEDs), saving approximately 184,000 kilowatt-hours in FY12 and substantially adding to employee safety as the replacement lighting provides a spectrum of light that allows for better visibility at night as compared to traditional HPS lighting. A study to add occupancy lighting sensors and replace existing sensors that are found to be defective continues. LLNL has evaluated the recommendations that would yield the highest savings in the eight facilities audited for FY11 for low-cost energy-conservation measures. This document lists those projects that have either been implemented or could be implemented.

At the end of FY12, three workers were certified as Qualified Certified Energy Managers (CEM). As funds become available, the number of these managers will increase as Facility Managers (FMs) or Facility Points of Contact (FPOCs) enroll in the program.

In addition, LLNL's Sustainability Communication Plan strove to engage employees to reduce electricity through simple conservation measures.

LLNL continued to reduce its electricity usage by an estimated 15.7% and natural gas by 17.7%, both from the FY03 baseline.

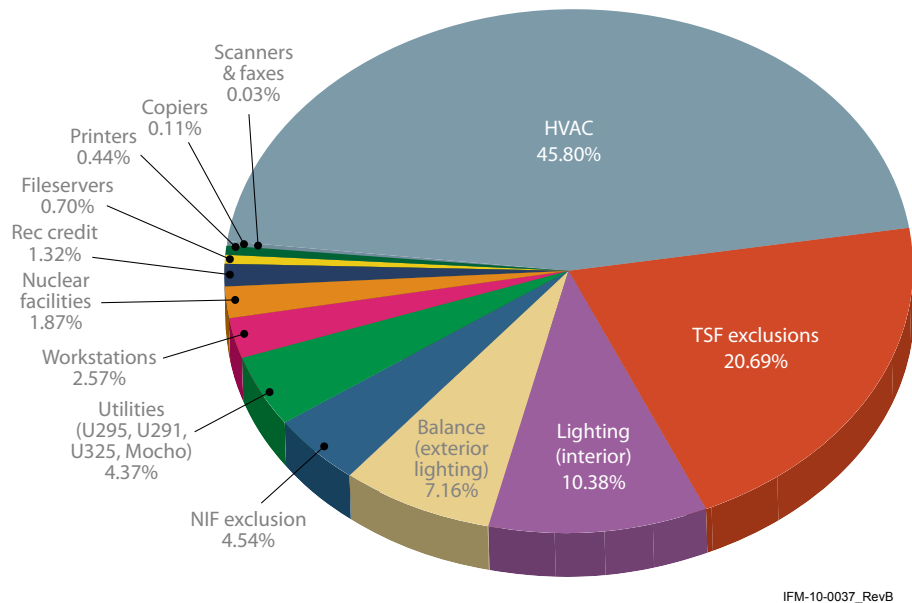


Figure 3-4. LLNL typical energy use breakdown (FY11 data).

Planned Actions

Several projects have been identified to reduce energy intensity at LLNL, such as interior and exterior lighting improvements, virtual servers, upgrading to high-efficiency motors, and installing variable frequency drives (VFDs). The chart in Figure 3-5 shows energy savings projects and their performance towards the reduction goal.

The existing deferred maintenance program will continue to reduce deferred maintenance, while at the same time increasing energy efficiency. When replacing aging equipment identified in the master deferred maintenance list, new equipment will be the latest, most energy-efficient type available. A new program that tracks the energy savings associated with deferred maintenance replacements was put in place in FY12.

Energy Savings Projects in Progress

Each line on the chart below corresponds to various approaches to Lab-wide energy savings projects. Most projects demonstrate savings in a stepped fashion based on major facility and infrastructure upgrades.

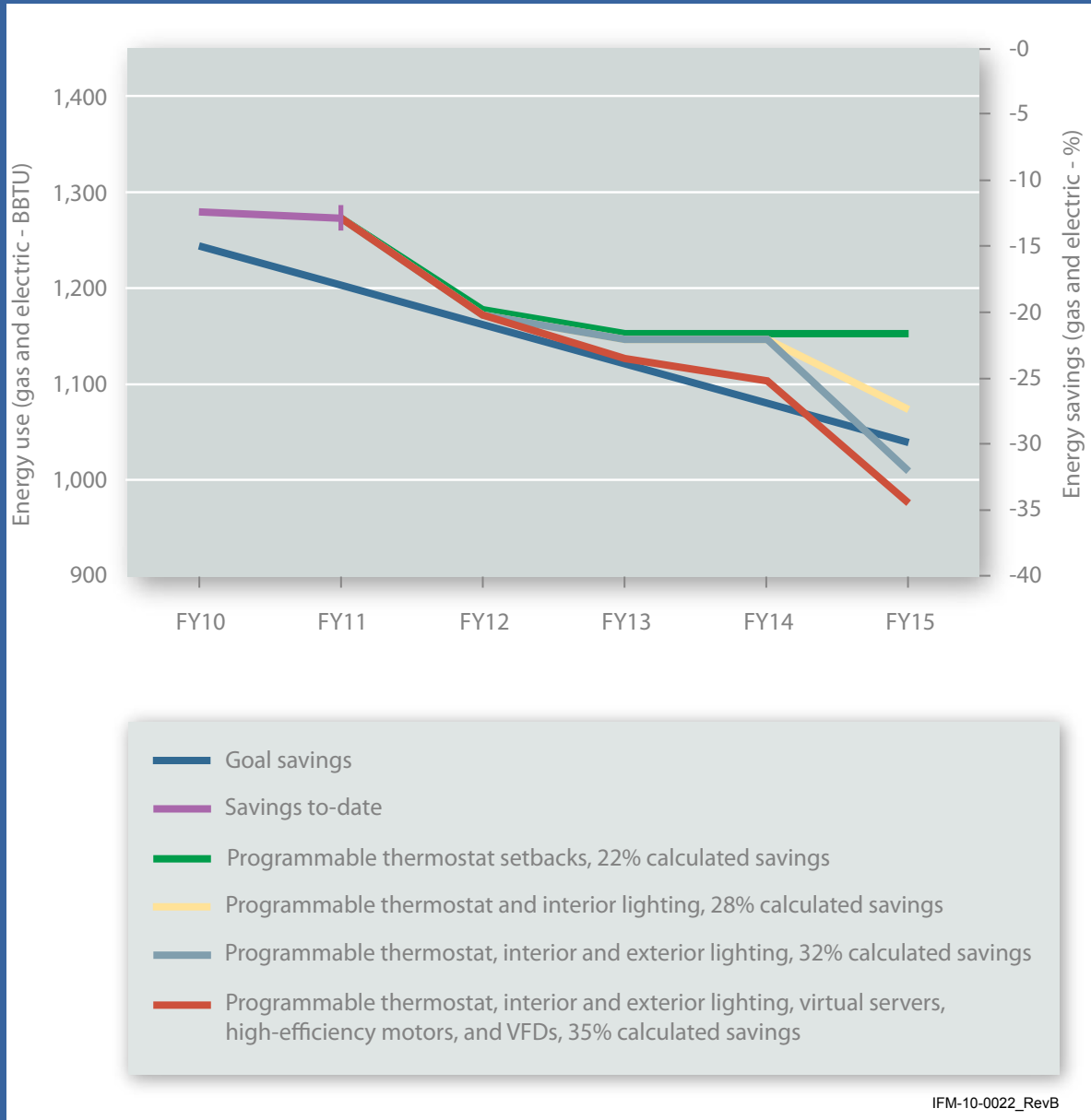


Figure 3-5. Lab-wide energy savings projects in progress.

LLNL is continuing to develop a strategy to justify energy conservation projects in comparison to its low cost of electricity.

In addition to reductions in energy intensity, electrical and gas utilization, the projects listed below will help reduce LLNL's GHG emissions.

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its energy intensity reduction goals.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Boiler Replacement Project - FY13	4	0.3	14.4	4	0	0	0
Boiler Replacement Project - FY14	5	0.3	14.4	0	5	0	0
Building Automation Systems/EMCS	5	0.9	5.4	2	2	2	0
Building Envelope Modifications	4.5	0.14	32.7	1.5	1.5	1.5	0
ECM 3.2 Facility Audits	3.5	0.9	3.8	3.5	0	0	0
Electric Motors and Drives, Variable Speed Motors or Drives	2	0.54	4.4	0.7	0.7	0.7	0
Site-wide Lighting Improvements, Exterior	3	0.4	6.5	1	1	0	0
Site-wide Lighting Improvements, Interior	5	3.8	1.3	0	0	5	0
TOTAL	32	7.4	4.3	13	10	9	0

IFM-12-0042_RevA

Figure 3-6. Proposed projects in support of SSPP Goal 1.2.

Goal 1.3

Goal: Individual buildings or processes metering for 90% of facilities for electricity (by October 1, 2012); for 90% of facilities for steam, natural gas, and chilled water (by October 1, 2015)

Performance Status

LLNL is on track to meet the advanced metering goals for 90% of the electricity by the end of FY12 and natural gas by the end of FY15 and achieved 96% of metering for electricity and 55% for natural gas in FY12.

In response to SSPP Metering Goal 1, "Install electricity meters on individual buildings or processes at each site so that these individually metered buildings and processes account for at least 90% of the site's total electricity use by October 1, 2012," LLNL has installed electricity meters that account for 96% of its total site usage.

In response to SSPP Metering Goal 2, "Install natural gas, steam and chilled water meters on individual buildings or processes so that these individually metered buildings and processes account for at least 90% of the site's natural gas, steam and chilled water use by the end of FY15," LLNL has currently achieved 55%, and projects to achieve 90% by the end of FY15.

Planned Actions

LLNL will continue to employ advanced meters to further understand how it uses energy in its facilities and will explore methods to use meter data to more effectively manage facility performance.

Funding Strategy

The projects listed below will ensure that LLNL facilities that use 90% of its energy and natural gas meet SSPP Metering Goal 2.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Natural Gas Metering	3.5	0.065	54	1.2	1.2	1.2	0
Water Metering	1.5	0.025	59	0.5	0.5	0.5	0
TOTAL	5	0.09	55	1.7	1.7	1.7	0

IFM-12-0043_RevA

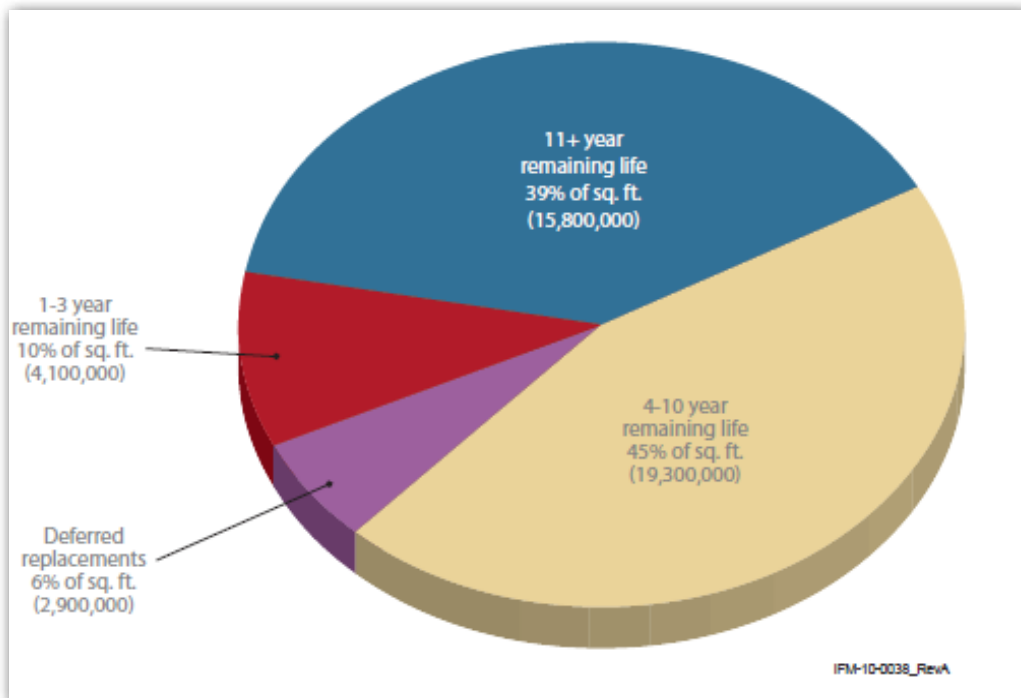
Figure 3-7. Proposed projects in support of SSPP Goal 1.3.

Goal 1.4

Goal: Install cool roofs, unless uneconomical, for roof replacements unless project already has CD-2 approval. New roofs must have thermal resistance of at least R-30.

Performance Status

Cool roofs have helped to reduce facility electrical usage by approximately 10% annually, thereby contributing to the overall reduction of GHG emissions. Currently, LLNL has 42M sf of roof area. 45% (19.3M sf) has a remaining life of four to ten years, 39% (15.8M sf) has a remaining life of eleven or more years, 10% (4.1M sf) with one to three years of remaining life. Cool roofs have been installed prior to FY12 on Buildings 041, 191, 404, 415, 482, 543, 551E, 551W, and 663. Cool roofs installed in FY12 were 1727, 291, 423 517, 801D and 801A Sections K & L. Figure 3-8 illustrates LLNL's expected roof life cycle.



IFM-10-0038_RevA

Figure 3-8. LLNL roof expected life cycle (percent square footage in category, replacement cost).

Planned Action

All roof replacements and new roofs at LLNL will be cool roof installations.

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its cool roof installation goals.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Cool Roofs - FY13	1	0.04	32.1	1	0	0	0
Cool Roofs - FY14	2	0.05	46.4	0	2	0	0
Cool Roofs - FY15	3	0.06	45.2	0	0	3	0
TOTAL	6	0.15	43	1	2	3	0

IFM-12-0044_RevA

Figure 3-9. Proposed projects in support of SSPP Goal 1.4.

Goal 1.5

Goal: 7.5% of annual electricity consumption from renewable sources by FY13 and thereafter (5% FY10–12)

Performance Status

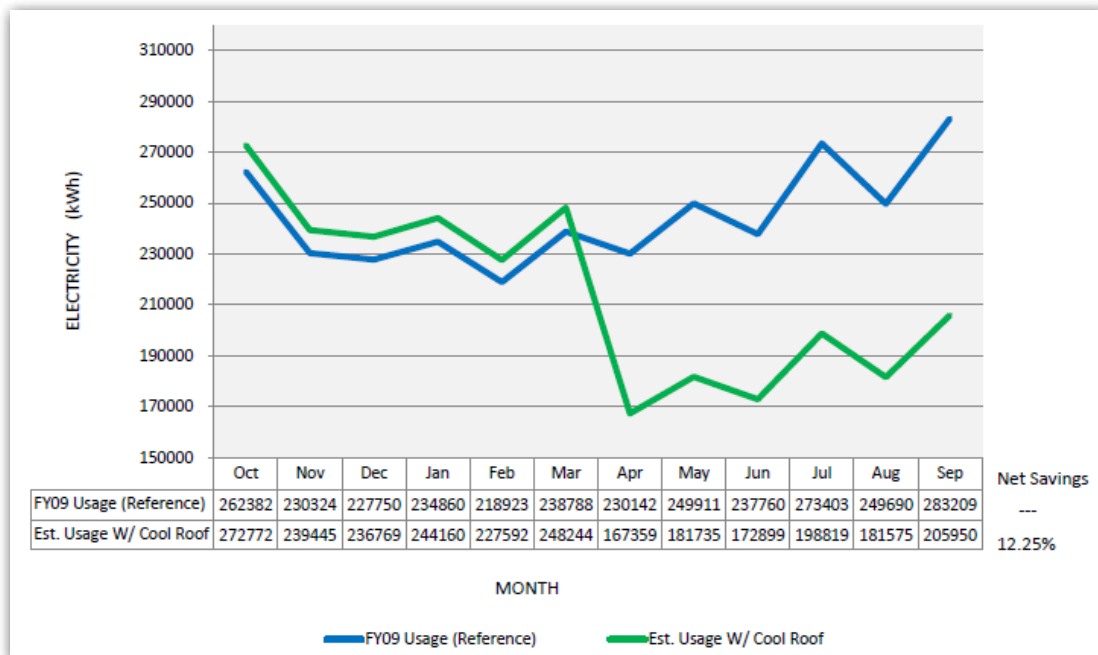
The FY12 requirement was met by the purchase of RECs through the Western Area Power Administration (WAPA).

Due to the low cost of purchased power, installing renewable energy at LLNL has been a challenge. LLNL is a member of the Northern California Sites Electric Power Consortium (the Consortium). The Consortium includes LLNL, Lawrence Berkeley National Laboratory (LBNL), Stanford Linear Accelerator Center (SLAC), and Sandia National Laboratory California. The Consortium currently utilizes two sources of power to meet its annual energy requirements: 1) the Central Valley Project (CVP) Base Resource allocation of hydropower; and 2) wholesale market power purchases. WAPA is the Consortium's procurement agent, and makes any required wholesale purchases on the Consortium's behalf.

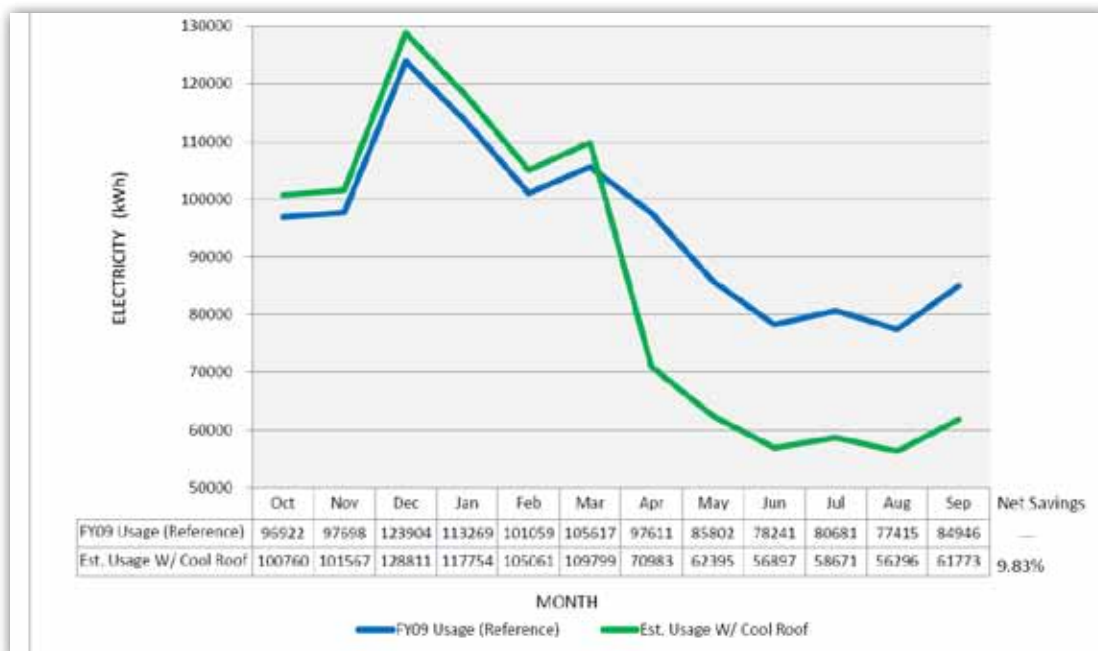
The wholesale power rates are considerably less expensive when compared to local public utilities such as Pacific Gas & Electric (PG&E). These low rates have also made renewable energy development incur a longer return on investment (ROI) relative to projects with standard utility rates. Because of the inexpensive power, the FY12 requirement that 7.5% of renewable source electricity was met through the purchase of RECs.

In FY11, LLNL completed a Site 300 renewable resource assessment and valuation. The report details the potential for wind and solar photovoltaic (PV) resources at LLNL's Site 300. A renewable resource assessment was completed for LLNL Site 200 in 2008. Two projects are currently being considered at LLNL by LSO as a result of these assessments. LSO's study includes a solar/PV project in the Site 200 and the Renewables Innovation and Development for Generation of Electricity (RIDGE) project, an on-site utility-scale renewable energy farm at LLNL's Site 300.

Installation of cool roof saves electricity



Building 191 roof (approximately 89K square feet)



Building 543 roof (approximately 36K square feet)

Figure 3-10. Cool roof electricity savings.

Planned Actions

The FY12 requirement has been met through REC purchases purchased for LLNL by LSO. On-site renewable energy projects for both research and electrical generation purposes are being explored, which would contribute towards the goal, reduce the amount of RECs purchased, and reduce LLNL's Scope 2 emissions.

Renewable energy projects are very capital intensive. In general terms, a 10MW solar array would be required to meet the renewable energy goals for LLNL; this would require an approximate \$100M investment. A 10MW solar array would also greatly contribute to LLNL's energy reduction goals as well. The high cost of on-site renewable power indicates an ROI that would exceed the projected 20-year useful life of the equipment. When compared to WAPA rates, renewable energy only becomes economically feasible when the producer is a private entity eligible for tax credits, tax exemptions, depreciation and other assorted incentives. A Power Purchase Agreement (PPA) with a private entity appears to be the best option for renewable energy at LLNL. The private entity would install, own, operate, and maintain a "behind the meter" renewable energy project. The additional funds needed to subsidize a PPA for renewable energy purchases would depend on the size, type, and location of renewable energy at LLNL.

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its electricity consumption from renewable sources goal.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Solar Photovoltaic - One MW Carport PV Plant (PPA)	0.030	0.14	0.2	0.03	0	0	0
Solar Photovoltaic - Ten MW PV Plant (PPA)	0.292	1.44	0.2	0.10	0.10	0.10	0
Solar Photovoltaic - Two MW PV Plant (PPA)	0.060	0.3	0.2	0	0.03	0.03	0
Wind Power	12	0.76	15.8	0	6	6	0
TOTAL	12.4	2.6	4.8	0.13	6.13	6.13	0

Figure 3-11. Proposed projects in support of SSPP Goal 1.5.

IFM-12-0045_RevA

Goal 1.6

Goal: 10% annual increase in fleet alternative fuel consumption by FY15 relative to a FY05 baseline

Performance Status

Based on earlier guidance from DOE, LLNL continued to focus its alternative fuel strategy on the use of ethanol fuel (E85) as its fuel of choice. In 2007, LLNL built an ethanol fuel station with a 12,000 gallon underground tank at a cost of \$1.3M. Subsequently, LLNL restructured its fleet to be composed of E85-compatible vehicles.

In FY12, LLNL's use of alternative fuels increased 4.4% relative to the previous year's consumption. Despite this increase, LLNL still struggles to meet the goal of 10% increase because of the mandated acquisition of hybrid vehicles. While hybrid vehicles offer substantial efficiency increases, they are not yet capable of using E85 fuel. In FY12, LLNL acquired additional E85 vehicles from GSA to replace conventional fuel vehicles. LLNL continues to maintain its fleet of electric vehicles on-site, and looks forward to developing approaches to expand the low-GHG fleet.

Planned Actions

LLNL will maintain its AFV fleet and continue to replace the existing fleet with E85 vehicles. LLNL will obtain additional electric vehicles and install supporting infrastructure as funding becomes available.

Funding Strategy

No projects are necessary at this time to allow LLNL to meet this goal.

Goal 1.7

Goal: 2% annual reduction in fleet petroleum consumption by FY20 relative to a FY05 baseline

Performance Status

In FY12, LLNL decreased its petroleum fuel consumption by 66% from the FY05 baseline, well exceeding the required annual 2% reduction and the cumulative 30% through the end of FY20. This reduction was achieved by replacing unleaded vehicles with AFVs, reducing miles driven, right-sizing the fleet, using on-site mass transportation, establishing vehicle preventive maintenance, and the introduction of hybrid vehicles into the LLNL vehicle fleet.

Planned Actions

LLNL will continue to strengthen its alternative fuel infrastructure by replacing conventional fueled vehicles with alternative fueled vehicles and by promoting the use of alternative fuels.

LLNL will continue to analyze and evaluate its fleet strategy through the following transportation initiatives.

Restructuring the fleet vehicle type.

LLNL is moving to smaller and more fuel-efficient vehicles and is determining the right vehicle type based on functionality including electric vehicles as discussed in Goal 1.6. The goal is to ensure that the vehicle provided is the type required to safely and efficiently perform needed tasks.

Restructuring the bicycle fleet.

LLNL has a fleet of approximately 500 bicycles that are used as an alternative method for on-site transportation. Twenty bicycles were purchased in 2012 that have new features including a chainless drive and airless tires. The bicycles will help improve employee safety and may reduce maintenance costs of the bicycle fleet.

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its reduction in fleet petroleum consumption goal.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Chainless Bicycles	0.4	–	–	0.13	0.13	0.13	0
Expanded Taxi Service	2.1	–	–	0.7	0.7	0.7	0
TOTAL	2.5	–	–	0.8	0.8	0.8	0

IFM-12-0049_RevA

Figure 3-12. Proposed projects in support of SSPP Goal 1.7.

Goal 1.8

Goal: 75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) starting in FY00 and thereafter

Performance Status

LLNL met and exceeded the required 75% replacement of fossil fuel light-duty vehicles with AFVs in FY12. A total of 84 light-duty vehicles were scheduled to be replaced in FY12; all 84 vehicles were replaced with E85. LLNL's current alternative fuel fleet accounts for 86.6% of the total light-duty vehicles.

Planned Actions

LLNL will continue replacing its fleet with AFVs as manufacturers make them available and exploring different alternative fueled vehicle options, specifically in the area of electric vehicles. LLNL will continue with its main alternative fuel vehicle strategy, which is based on E85. With this initiative, the AFV fleet mix will include hybrid vehicles as replacements for regular unleaded or diesel vehicles.

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its AFV light duty vehicle purchases goal.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Electric Vehicles and Charging Stations							
TOTAL							

IFM-12-0050_RevA

Figure 3-13. Proposed projects in support of SSPP Goal 1.8.

Goal 1.9

Goal: Reduce fleet inventory by 35% within the next 3 years relative to a FY05 baseline

Performance Status

The FY12 fleet reduction goal at the NNSA organizational level was 4%.

To right-size its government vehicle fleet, LLNL annually surveys and analyzes its number of vehicles. The on-site transportation analysis was in the areas of vehicle functionality, vehicle usage, vehicle type, and vehicle options.

Planned Actions

To compensate for possible vehicle reductions, LLNL will implement institutional vehicle pool concepts to allow employees to share the use of vehicles. The fleet management team is exploring the use of new technology and tools to assist in developing an efficient vehicle pool program.

Based on the results and recommendations from the on-site transportation analysis, LLNL may expand its on-site mass transportation services (shuttle services) by increasing its number of taxis from two to seven. The goal will be to increase the use of mass transportation other than individual vehicles, thereby reducing the use of petroleum fuel and the number of miles traveled.

New vehicle technology such as Global Positioning System (GPS) and vehicle reservation module.

GPS system will track vehicle utilization, idle time, engine “on” time, mechanical operation, and inventory control. This information will be used to manage the fleet more efficiently in terms of number of vehicles, maximization of vehicle utilization, up-to-date vehicle engine diagnostics and maintenance, and vehicle emissions. The reservation module will allow the reserving of vehicles from a fleet pool. By having this capability, LLNL will be able to right-size the number of vehicles and provide the right vehicle type mix in its fleet.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Shared Vehicle Fleet							
TOTAL							

IFM-12-0051_RevA

Figure 3-14. Proposed projects in support of SSPP Goal 1.9.

Goal 2.1

Goal: 13% Scope 3 GHG reduction by FY20 from a FY08 baseline

Scope 3 includes all indirect emissions not included in Scopes 1 and 2.

The sources of Scope 3 emissions are broad, sometimes difficult to measure with high precision, and in many cases must be estimated. As demonstrated in Figure 3-2, employee commuting continues to account for the majority of Scope 3 emissions.

Included in LLNL Scope 3 GHG emissions are the following:

- Employee commuting
- Employee business travel
 - Air travel
 - Rental or privately owned vehicle mileage
- Off-site domestic wastewater treatment
- Off-site municipal solid waste disposal
- Electrical transmission and distribution losses

Performance Status

In FY12, according to the LLNL GHG inventory, the Laboratory continued to achieve a reduction of more than 9% in Scope 3 emissions from the FY08 baseline. Although there were no substantial reductions from the previous year, LLNL remains below the FY08 baseline target.

With a slight reduction from the previous year in travel, combined with no substantiated change in commuting and an increase in electrical utilization, LLNL has remained more than 9% below the FY08 baseline. Transmission, distribution, wastewater, and waste disposal are all considered mission support sources.

Analysis of a recently conducted commuter inventory is in progress. The survey findings will help determine future actions to help reduce commuting miles, and will potentially provide a more accurate representation of GHGs generated by commuting.

Planned Actions

LLNL Scope 3 emissions reductions will continue to focus on employee commuting and travel. Efforts include:

- Providing incentives for using public transportation, carpooling, and vanpooling
- Increased teleworking when practical
- Communication of LLNL sustainable travel policy to employees
- Evaluating the effectiveness and cost of additional video conferencing equipment to offset air travel
- Offering additional incentives to encourage alternate commuting
- Upgrading the on-site electric transmission and distribution system to reduce line losses
- Continuing the investigation of alternative methods of providing electrical charging stations for POVs
- Exploring ways of linking an onsite charging station with other innovative solutions, such as PV

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its Scope 3 GHG reduction goal.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
High Definition Conference Rooms	0.9	0.6	1.5	0.3	0.3	0.3	0
Carpooling Incentives	0.3	0	–	0.1	0.1	0.1	0
TOTAL	1.2	0.6	2	0.4	0.4	0.4	0

IFM-12-0052_RevA

Figure 3-15. Proposed projects in support of SSPP Goal 2.1.

Goal 3.1

Goal: 15% of the number of existing buildings greater than 5,000 gross square feet (GSF) to be compliant with the five guiding principles of HPSB by FY15

Performance Status

LLNL is set to meet the FY15 goal of assessing 15% of the enduring inventory exceeding 5,000 square feet using the LEED system or the DOE HPSB assessment tool. Based on square footage, the task is 44% complete. Based on number of buildings, the task is 41% complete.

Building 451 was submitted for U.S. Green Building Council review in December 2010 and received the council's rulings in late April 2011. Five initial building assessments using the DOE HPSB assessment tool were also completed in 2011. These five buildings have met the requirements of the five HPSB Guiding Principles: Integrated Design, Energy Performance, Water Use Reduction, Indoor Environmental Quality, and Materials Conservation.

Planned Actions

Building 311 is scheduled for USGBC LEED submittal, and buildings 1677, 1879 and 1889 are scheduled for DOE HPSB assessments in FY12.

Buildings 1739, 1878, 1879, 5627 and 6925 are scheduled for DOE HPSB assessments in FY13.

Funding Strategy

The following project, if implemented, would allow LLNL to meet its HPSB goal.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
HPSB Certification	0.45	0	N/A	0.15	0.15	0.15	0
TOTAL	0.45	0	N/A	0.15	0.15	0.15	0

IFM-12-0053_RevA

Figure 3-16. Proposed projects in support of SSPP Goal 3.1.

Goal 3.2

Goal: All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the GPs and where the work exceeds \$5 million, each are LEED–NC Gold certification or equivalent

Performance Status

All new construction greater than \$5M will be LEED Gold certified. All new construction less than or equal to \$5M will meet the HPSB guiding principles.

Funding Strategy

Line item funding is being requested for construction of a new EOC in FY14 which will be built to meet LEED Gold requirements.

To achieve LEED Gold certification, construction costs are generally 10% higher than usual.

Goal 3.3

Goal: Regional and local planning

Performance Status

Executive Order 13514 instructs federal agencies including DOE to meet the following regional and local planning goals:

- Participation in regional transportation planning, recognition of existing community transportation infrastructure, and incorporation of such efforts into site planning policy and guidance documents
- Efforts to ensure planning for new federal facilities or new leases includes consideration of sites that are pedestrian friendly, near existing employment centers, and accessible to public transit, and emphasize existing central cities and planned communities
- Identify and analyze impacts from energy usage and alternative energy sources in all Environmental Impact Statements and Environmental Assessments on proposals for new or expanded federal facilities under the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.)
- Coordination efforts with regional programs for federal, state, and local ecosystem, watershed, and environmental management
- Identify regional transportation planning, ecosystem, watershed, and environmental management initiatives affecting sites and opportunities to work with local authorities to align energy policies and siting of renewable energy infrastructure
- Efforts to assess the state of interaction between site and their local/regional organizations and improvements to increase interaction

Local Planning Coordination

LLNL maintains very good relationships with local community planning and government groups, including the cities of Livermore and Tracy, as well as the counties of Alameda, Contra Costa, and San Joaquin.

Interactions include frequent meetings with City of Livermore planners to discuss the Livermore Valley Open Campus (LVOC) proposal, discussions with water officials in Livermore to discuss wastewater issues, and participation in stakeholder groups to discuss environmental issues. LLNL has also advised the City of Livermore in the development of its 2012 Climate Action Plan.

Transportation

The Laboratory recognizes the existing community transportation infrastructure and works with multiple local and state agencies on transportation planning, providing input on the selection of future Livermore stations served by regional transit (BART), and promoting public transit commuting ridership.

With more housing developed close to LLNL and the increasing awareness of personal fitness and energy conservation, the bicycle remains a popular seasonal method of commuting.

As a major employer in the community, the Laboratory is committed to supporting commuters using alternate modes of transportation rather than the single-occupant vehicle. The Laboratory provides certain on-site conveniences to promote energy conservation:

- Permitting access for vanpools to route through the limited areas
- Maintaining a database to facilitate rideshare and vanpool matching
- Providing preferential parking spaces for vanpool vehicles
- Offering free bicycle safety helmets to on-site riders and bicycle commuters
- Providing on-site taxi shuttle service

Planned Actions

Sustainable site development encompasses an integrated approach to the planning of future on-site facilities and infrastructure, consistent with the LLNL Twenty-Five Year Site Plan (TYSP), striving for good site stewardship. The Laboratory encourages walking and bicycling as means of travel within the site; long-range site development envisions continuous improvement of a bicycle- and pedestrian-friendly environment.

- Future facilities development will be physically scaled and organized to maximize the potential of walking and bicycling on site (refer to Goal 1.7)
- Sidewalks and landscaped pathways will continue to be developed, providing safe and direct travel for pedestrians segregated from vehicle traffic; bicycle travel is accommodated by bike lanes or shared-use pathways wherever feasible
- LLNL supplies and maintains approximately 500 unassigned bicycles for employee use on site; riders can leave bicycles at destinations; bicycles are redistributed daily around the site
- Plan on-site taxi shuttle stop locations within a quarter mile (reasonable walking distance) radius from major on-site destinations

Goal 4.1

Goal: 26% water intensity reduction by FY20 from a FY07 baseline

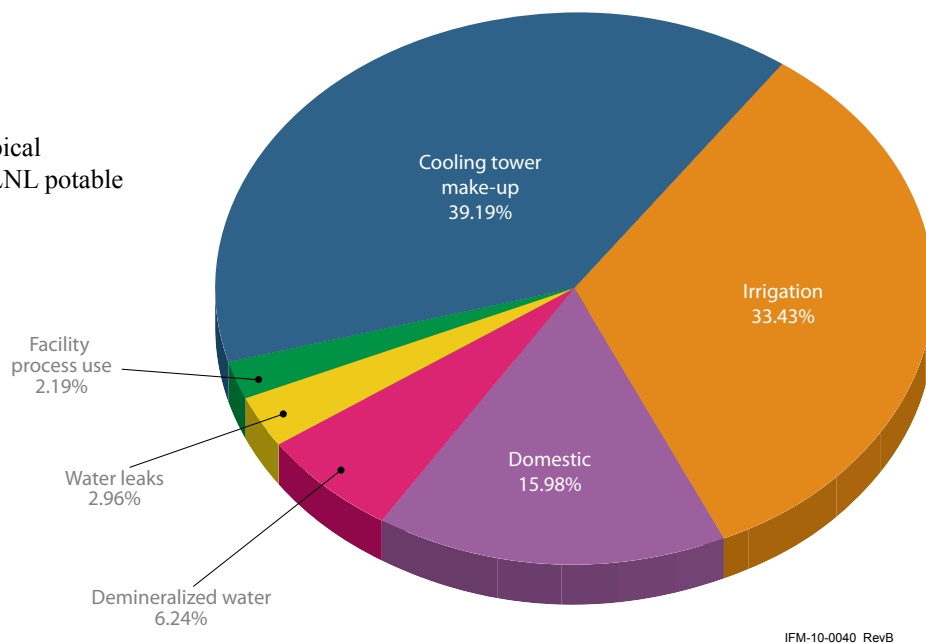
Performance Status

In FY12, LLNL will achieve an estimated 7% water use reduction, not meeting the federal goal of 10%. This was mainly due to mission growth at the Terascale Simulation Facility (TSF) and the unavoidable switch to an alternate water supply while the main supplier is down for maintenance. LLNL is working toward meeting the FY15 goal of reducing water intensity by 16%. Current LLNL practice is to meter areas or zones of greatest water use, such as the cooling towers and irrigation zones, rather than individual buildings. A breakdown of LLNL potable water consumption is illustrated in Figure 3-17.

There are several factors that will make it difficult to meet the FY20 goal without resources to execute the needed water savings projects. Some challenges in the future include the following:

- For approximately two months of each year, the main supplier of LLNL potable water is down for maintenance. This directly impacts the make-up water to the cooling towers. At least 1% of LLNL's total annual consumption will be expended because the alternate supplier's water quality has less desirable attributes and allows for only a few cycles of concentrations at the cooling towers.
- Future plans for the Applied Energy Simulation Center and other projects will impose higher water demands. It is estimated that an additional 20,000 kgals will be required annually.

Figure 3-17. Typical breakdown of LLNL potable water use.



Planned Actions

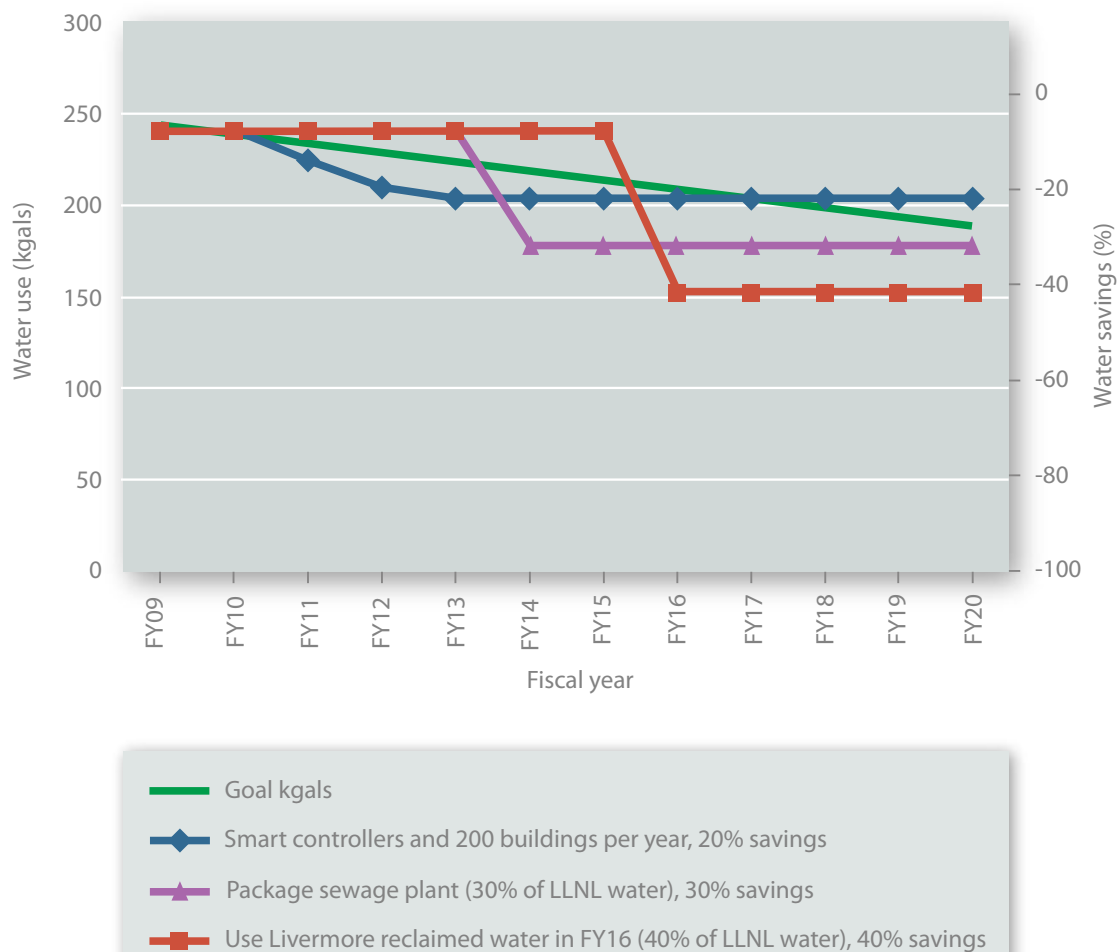
LLNL will need more water savings measures and resources to meet FY15 and FY20 goals.

There are several water conservation projects underway, or being planned, that will assist the Laboratory in meeting the federal water reduction goal. One project, construction of a modular sewage plant at LLNL, will save 95,000 kgals annually, a 30% savings of LLNL water.

Figure 3-18 illustrates the savings potential approaches to future potable water savings may provide.

Potential Approaches to Future Potable Water Savings

Smart controllers, plumbing improvements and a modular sewage treatment plant or other forms of reclaimed water use are being evaluated to help LLNL meet its water intensity reduction goal.



IFM-10-0026_RevA

Figure 3-18. Potential approaches to future potable water savings.

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its water intensity reduction goal.

Project	Project Cost (\$M)*	Annual Savings (\$M)	Simple Payback (Yrs)	FY15 (\$M)	FY16 (\$M)	FY17 (\$M)	FY18 (\$M)	FY19 (\$M)
Plumbing Improvements - FY15	1	0.03	35.9	1	0	0	0	0
Plumbing Improvements - FY16	2	0.03	71.8	0	2	0	0	0
Plumbing Improvements - FY17	2	0.03	71.8	0	0	2	0	0
Water and Sewer Conservation Systems - install 'smart' irrigation controllers - FY16	1	0.03	29.8	0	1	0	0	0
Water and Sewer Conservation Systems, Modular Sewage Plant	9.9	0.79	12.3	0	0	3.3	3.3	3.3
Drought Tolerant Landscape FY16	2.3	0.04	56.9	0	2.3	0	0	0
Drought Tolerant Landscape FY17	1.5	0.04	37.1	0	0	1.5	0	0
Drought Tolerant Landscape FY18	0.5	0.04	12.4	0	0	0	0.5	0
Drought Tolerant Landscape FY19	1.1	0.04	27.2	0	0	0	0	1.1
TOTAL	21.3	1	19.7	1	5.3	6.8	3.8	4.4

Figure 3-19. Proposed projects in support of SSPP Goal 4.1.

IFM-12-0046_RevA

Goal 4.2

Goal: 20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY20 from a FY10 baseline

Performance Status

LLNL uses potable water for industrial purposes (i.e., cooling tower make-up) and landscaping irrigation at Site 200. At Site 300, potable water is used for all purposes.

The 20% water consumption reduction of ILA water does not apply to LLNL strictly since, by definition, ILA is non-potable water. LLNL is committed to reducing industrial use of potable water at the cooling towers and for landscape irrigation. As a subset of the water reduction savings, the portion attributable to ILA can be tracked. In FY12, the combined industrial and irrigation consumption was reduced by 2% from the FY10 baseline. In FY12, LLNL installed its largest xeriscaping project to date at the West Gate Badge Office.

Planned Actions

LLNL has completed the LLNL Sustainable Landscape Concept Plan which provides design directions and a planting palette for future projects. Future landscaping projects, when funded, will conform to the plan. The plan incorporates sustainable best practices regarding the use of drought-tolerant planting, "xeriscape," or native landscaping.

- Installation of irrigation smart controllers and plumbing improvements on 200 buildings will save 25,000 kgals annually, which equates to a 20% savings of LLNL water.
- The Laboratory will continue to investigate the use of Livermore reclaimed water for irrigation with a goal for site-wide application, which has a potential saving of 125,000, which equates to a 40% savings of LLNL water.

Funding Strategy

Projects that, if implemented, would allow LLNL to meet its ILA water consumption reduction goal are listed in Goal 4.1.

Goals 5.1 and 5.2

Goal: Divert at least 50% of non-hazardous solid waste, and construction and demolition materials and debris by FY15

Performance Status

LLNL's pollution prevention efforts have been guided by the Executive Orders, yet are firmly entrenched in its management practices. Many of the goals have been in place at LLNL and have been exceeded. Pollution prevention is a key component of LLNL's environmental stewardship programs.

- **Goal:** Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris by the end of FY15.

LLNL status: LLNL consistently meets or exceeds this goal. In FY11, LLNL diverted 58%. In FY12, as of early Q4FY12, LLNL has already diverted 52%. Note that recycled scrap metal data is not available until mid-October and is expected to significantly increase LLNL's FY12 diversion rate.

- **Goal:** Divert at least 50% of construction and demolition materials and debris by the end of FY15.

LLNL status: LLNL consistently meets or exceeds this goal. Improved tracking of construction and demolition materials and debris continues in FY12. In FY11, LLNL diverted 88%. In FY12, as of early Q4FY12 LLNL has already diverted 57%.

Toxic Chemical Reduction

Using a priority-based approach, LLNL addresses the chemical usage reduction requirements of EO 13514 that focus on toxic, hazardous, and GHG-contributing chemical emissions. Twenty-seven chemicals were selected as LLNL priority chemicals in 2008 and continue to be tracked and reported regularly (Figure 3-20).

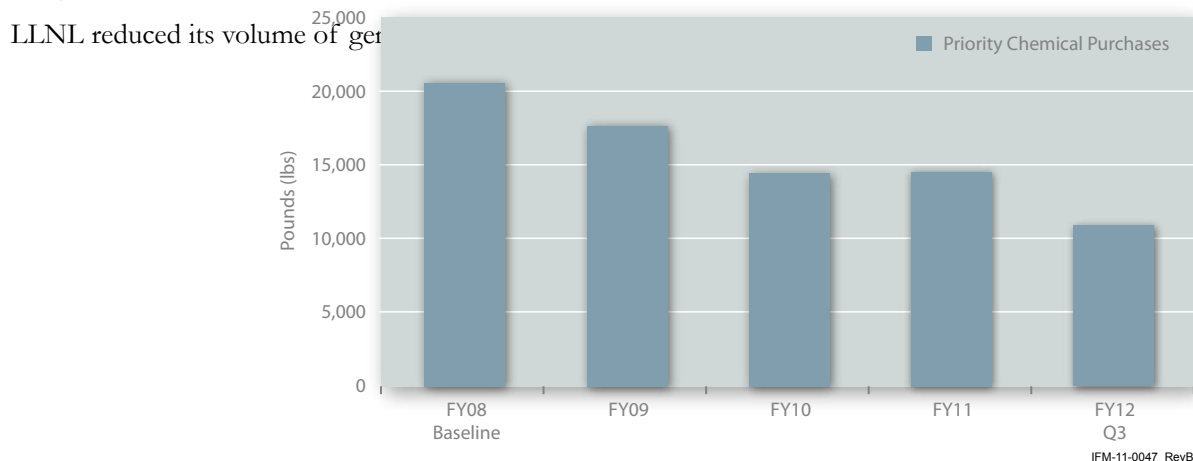


Figure 3-20. The amount of priority chemical purchases continues to decline.

extremely hazardous waste, LLW and LLW-mixed.

LLNL continues to have an integrated pest management program and other appropriate landscape management practices.

Paper Use

LLNL continues to focus on reducing printing paper and to purchase uncoated paper containing at least 30% post-consumer fiber in accordance with EO 13514 goals. The Laboratory is identifying opportunities to go paperless when possible.

In FY12, the Managed Print Services Program (MPS) continued to be expanded Lab-wide. Under the MPS, equipment selections include environmental benefits such as double-sided (duplex) printing and PDF capabilities to reduce paper usage, and they use solid ink technology instead of traditional toner cartridges. The overall result is continued reduction of single-use machines and business machine consumables.

Waste Minimization and Recycling

LLNL regularly exceeds the EO 13514 goal which specifies that agencies divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris, by the end of FY15. However, in FY12 CalRecycle passed AB341, Mandatory Commercial Recycling, and Alameda County enacted an associated ordinance. Phase 1 of the ordinance (enforceable as of January 1, 2013) requires that LLNL implement site-wide recycling for paper, cardboard, aluminum cans, and food glass HDPE and PET bottles. Currently, LLNL has implemented a partial comingled recycling and composting program in fifteen buildings (~20% of the site). Phase 2 of the ordinance goes into effect in 2013 with enforcement commencing on January 1, 2014, which requires mandatory composting.

Planned Actions

LLNL plans to continue to reduce pollution and increase recycling during FY12 by:

- Raising awareness through awards and outreach
- Improving tracking of construction and demolition materials and debris
- Looking for opportunities to expand materials sent for recycling (such as plastics)
- Expand comingled and composting program

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its goal to divert at least 50% of waste and debris from the waste stream.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Site Wide Recycling (50% of LLNL Buildings)	0.8	0	0	0.2	0.2	0.2	0.2
Site Wide Recycling (100% of LLNL Buildings)	2.5	0	0	0.63	0.63	0.63	0.63

IFM-12-0056_RevA

Figure 3-21. Proposed projects in support of SSPP Goal 5.1 and 5.2.

Goal 6.1

Goal: Procurements meet sustainability requirements by including necessary provisions and clauses (95% each year)

Performance Status

LLNL is dedicated to incorporating sustainability requirements into its purchasing and contracting language. According to policy, LLNL ensures 95% of new contract actions, including task orders under new contracts and existing contracts, require the supply or use of products and services that conform to the following characteristics:

- energy efficient (ENERGY STAR or Federal Energy Management Program [FEMP]-designated)
- water efficient
- bio-based environmentally preferable (including Electronic Product Environmental Assessment Tool [EPEAT]-registered products)
- non-ozone depleting
- contain recycled content
- non-toxic or incorporate less toxic alternatives

LLNL is purchasing standard copier/printer paper with 30% recycled content.

LLNL has implemented an Affirmative Procurement Program (APP) which ensures environmentally preferable products and services, recycled content products, and biobased products are purchased to the maximum extent practicable and are consistent with federal law and related procurement requirements, including EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management, and the DOE Affirmative Procurement Program Guidance. LLNL mandates that these program requirements be followed as part of the Integrated Safety Management System (ES&H Manual Volume III, Part 30: General Environmental Controls, Document 30.1 Managing Environmental Aspects through Pollution Prevention). Sustainable acquisition or Environmental Affirmative Procurement Program (EPP) clauses requiring subcontractors to utilize environmentally preferable products/services and recovered/recycled content are now incorporated into all LLNL General Provisions (GPs) for purchase orders and subcontracts, except for the Standard Research General Provisions which apply to subcontracts awarded for basic or applied research and/or development work. In order to assist in complying with these requirements, LLNL continues to implement Procurement Standard Practice (SP) 23.5, Environmental Affirmative Procurement and Waste Reduction Requirements. This SP describes the APP and Waste Reduction Program (WRP) requirements as they apply to Laboratory procurement activities. This SP is reviewed annually to ensure all regulatory revisions, updates, and changes have been incorporated.

In FY12, the Pollution Prevention Program (P2S) worked with Procurement to make improvements to the sustainable acquisition offerings in LLNL's standard office supplies catalog. Boxes of facial tissue and KimWipes have now been substituted with recycled content equivalents. P2S also continues outreach and training on sustainable acquisition throughout the Laboratory population.

In FY12, LLNL received DOE's first Green Buy award at the Gold level for achievements in sustainable acquisition.

Planned Actions

In FY13, EPEAT requirements will expand to include purchases of imaging equipment (copiers, printers, scanners) and televisions. LLNL will work to implement training and monitoring for these new requirements.

LLNL shall continue to update affirmative procurement plans (also known as green purchasing plans or environmentally preferable purchasing plans), policies, and programs to ensure that all federally mandated designated products and services are included in all relevant acquisitions.

LLNL will continue to support the purchase of environmentally preferable products and services, recycled content products, and bio-based products, to the maximum extent practicable, by ensuring the clauses identified in the General Provisions are included in all purchase orders and subcontracts.

LLNL will continue to annually review and update Standard Practice 23.5 in accordance with its prime contract requirements.

Funding Strategy

No projects are necessary at this time to allow LLNL to meet this goal.

Goal 7.1

Goal: All data centers are metered to measure a monthly Power Utilization Effectiveness (PUE) (100% by FY15)

Performance Status

A survey was conducted to determine the number of data centers that will meet the criteria. It was determined that LLNL has 52 data centers.

Planned Actions

Consolidate data centers and virtualize servers as appropriate to reduce operating costs and improve efficiencies.

Install electric meters on its data centers.

Funding Strategy

The following is a list of projects that, if implemented, would allow LLNL to meet its data center metering goal.

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Data Center Metering	0.7	N/A	N/A	0.25	0.25	0.2	0
TOTAL	0.7			0.25	0.25	0.2	0

Figure 3-22. Proposed projects in support of SSPP Goal 7.1.

IFM-12-0059_RevA

Goal 7.2

Goal: Maximum annual weighted average power utilization effectiveness (PUE) of 1.4 by FY15

Performance Status

As a part of its ongoing contributions to mission excellence, LLNL continues to research and develop techniques to improve the energy efficiency of high performance computing (HPC), a highly energy intensive resource. LLNL is involved in a number of efforts that not only aim to reduce the energy use of HPC, but promote new standards of quantifying efficiency gains beyond gross energy use. LLNL aims to drive the DOE complex to adopt these approaches to use computational efficiency as a viable alternative to measuring advances in HPC sustainable stewardship. This will lead to the development of useful HPC performance metrics in relation to energy efficiency of an HPC platform.

Advanced energy-efficient computing requires revising the techniques of parallel processing, where multiple processors run at once to solve a problem. Efficient computing techniques require individual processors to work at their optimal efficiency for the task at hand; some would need to be powered down if they were not needed or if their complimentary processors were not yet done with their tasks. This is a departure from the traditional parallel computing perspective. LLNL has held the number one spot on the “Green 500” list since June 2012 for the most energy efficient computers in the world; five LLNL computers are listed in the top 100 of “Green 500.”

LLNL continues to optimize the efficiency of HPC with the new Sequoia platform. While a combination of liquid-cooling and air-cooling techniques were used in the installation of Sequoia, more than 90% of the machine is liquid-cooled.

Planned Actions

Building two data centers that incorporate the free cooling concept (Figure 3-23).

Investigate free cooling at buildings 112 and 451 data centers, and install free cooling at building 453 data



IFM-10-0017_RevA

center.

Funding Strategy

To leverage the TSF into exascale computing and to take advantage of “free cooling,” which will enable the use of outside air for the cooling process, approximately \$5.5M is needed. This investment would save an estimated 16M kWh per year and has a payback period of four years. The TSF free cooling design is

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Data Center Efficiency, Virtual Servers	0.5	0.41	1.2	0.5	0	0	0
B453 Terascale Free Cooling	5.5	0.72	7.6	0	2.75	2.75	0
B451 Free Cooling	3	0.36	8.3	0	1.5	1.5	0
B112 Free Cooling	3	0.36	8.3	0	1.5	1.5	0
Data Center Building	10	0.72	13.8	0	10	0	0
Server Consolidation	3	0.72	4.2	1	1	1	0
TOTAL	25	3.30	7.6	1.50	16.75	6.75	0

IFM-12-0060_RevA

Figure 3-24. Proposed projects in support of SSPP Goal 7.2.

complete.

The following is a list of projects that, if implemented, would allow LLNL to meet its PUE goal.

Goal 7.3

Goal: Electronic stewardship —100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY12

Performance Status

LLNL has made significant progress during FY12 to improve and automate electronic stewardship of its personal computing environment and has completed its FY12 Desktop/Laptop Power Manager Project ahead of schedule. Power management has been actively implemented and is in use on all eligible

Computer Power Management Savings Calculator Annual Savings Estimate			
	Energy Saved (kWh)	Dollars Saved	Pollution Prevented CO ₂ (tons)
Savings from monitors going into sleep mode	706K	\$42K	1,625
Savings from desktops going into CPU throttle mode	1,502K	\$90K	3,459
Total Savings	2,208K	\$132K	5,084

IFM-12-0063_RevA

Figure 3-25. Annual savings estimate to be achieved from PC, laptop, and monitor power management.

PCs, laptops, and monitors. Figure 3-25 shows the estimated annual savings LLNL will see from the implemented power management.

Planned Actions

LLNL will continue its power management on all eligible PCs, laptops, and monitors. As computers are replaced, new systems will automatically be included in the power management program.

Funding Strategy

Project	Project Cost (\$M)	Annual Savings (\$M)	Simple Payback (Yrs)	FY13 (\$M)	FY14 (\$M)	FY15 (\$M)	FY16 (\$M)
Macintosh Power Management	0.15	0.013	12	0.15	0	0	0
TOTAL	0.15	0.013	12	0.15	0	0	0

IFM-12-0061_RevA

Figure 3-26. Proposed projects in support of SSPP Goal 7.3.

stewardship goal.

Goal 8

Goal: Site innovation and government-wide support

Performance Status

Sustainability at LLNL is a guiding principle to aid both internal, site-level goals and Laboratory stakeholders, as well as external stakeholders, including the federal government and the nation as a whole. Internally, at the LLNL site, this has occurred through two paths; excellence in environmental stewardship, and the incorporation of sustainability into site-level decision-making about financial, space, energy and water resource uses. The environmental efforts are described in the following sections. LLNL is striving to coordinate cross-lab efforts in sustainability, that fall in line with its mission, so that the sustainable goals of the Lab can be seamless with overall Lab success. For its external partners, LLNL has supported stakeholders and government missions in a number of ways; both through long-term large scale science initiatives, and through smaller scale projects.

In FY12, LLNL funded over \$4M in Sustainability-related LDRD funding, not including NIF LDRD allocations and PAD-level internal funded projects. This funding enabled research and development of techniques, tools, and technologies that will help ensure the nation's national security through greater understand of climate trends, energy efficiency and GHG reduction.

Sustainability Successes in Environmental Restoration

Since beginning the environmental restoration activities at the two LLNL sites under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in the 1980s, a broad spectrum of environmental remediation technologies have been and continue to be tested and applied to clean up soil and groundwater contamination as efficiently and effectively as possible.

An indirect benefit of the environmental remediation work is the availability of treated pumped groundwater that is permitted to be discharged to surface storm drains that may be diverted for irrigation

needs or other possible industrial uses (e.g., cooling tower make-up water) and thereby reducing the reliance on the municipal water supply.

Large, High-Impact Research and Development

LLNL has been pursuing research that contributes to reduction of GHG emissions at a national and global scale, and in making the energy system more efficient. These include award-winning research in regional climate change prediction and analysis, greenhouse gas emission verification, and underground coal gasification and carbon capture and sequestration. These innovations will be realized in the next 15-30 years, with significant impacts.

Short-Term Scientific Advancement

LLNL R&D continues to focus on short-term scientific advancement of topics that promote more sustainable energy systems and specific technology deployment, such as Wind Power Prediction, Air Capture and Negative Emissions, Advanced Transportation Research, Building Energy Efficiency Simulation, and Energy Systems Simulation. These projects will trigger national and global GHG emission reductions in the 5-20 year time frame.

Sustainability Communication Plan

Fostering sustainable practices at LLNL is based on creating culture change. LLNL employees intrinsically understand that sustainability is crucial for us, and future generations to which will be left the nation and planet. It is the mission of the Sustainability Communications Plan to make all employees aware of what they can do to help. LLNL has been communicating the “sustainability message” to employees for many years through Newsline articles, posters (Figure 3-27), and through “walk the talk” actions, like installing new programmable thermostats. The formalized Sustainability Communications Plan and efforts were united by working with the Environmental Management System team, an interdirectorate working group, to enhance and standardize the sustainability message to employees.

Planned Actions

LLNL will continue to integrate research and development with site-level sustainability support through innovative projects that take advantage of on-site scientific expertise. Some examples of these synergistic projects include Building Energy Efficiency, Computational Efficiency, Renewable Energy, and SF6 reduction.

Where possible, remedies are selected that are relatively simple to implement and maintain, require less energy to support, and generate less waste. For instance, in certain situations ‘monitoring only’ has been selected as an appropriate remedy as the contaminants in question (e.g., tritium) have been shown to naturally attenuate without posing unacceptable risks. In other cases, subsurface conditions are being enhanced to promote in situ destruction of volatile organic compounds (VOCs). Bioremediation of VOCs in the subsurface is currently being tested at both LLNL sites and preliminary results are showing promise. Another approach involves injection of zero valent iron (ZVI) into the subsurface via mechanical fracturing technology. In this application, contaminants in groundwater will come into contact and react with the emplaced ZVI as the groundwater follows its normal flow pattern thereby decomposing to less toxic compounds. This work is planned for FY12. Although there is an up-front investment into setting up in situ remedies, over time there is less energy required and less waste generated while treating contamination to acceptable standards.

Funding Strategy

The S&T funding stream has not yet been allocated for FY12.

Changing the Culture

To raise awareness and help change the culture of LLNL employees, a series of “Striving for Sustainability” posters were distributed through Newsline, LLNL’s online employee news resource. The posters were also placed in selected buildings, including the cafeterias.



Figure 3-27. Communicating the “sustainability message” through posters.